# CA implementation in irrigated summer and winter field crops by integrating raised bed planting and double minimum tillage

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# Introduction

Conservation agriculture in its applicable implemented package and compatible with the realities of the production environment in small scale irrigated wheat based sequential cropping systems or farms is practically recommended using double minimum tillage plus furrow irrigated raised bad planting system. While through its long term complete continuous implementation, the advantages of reducing production costs of labor and machineries, keeping the least part of residue on the soil surface and the most part of residue into the soil instead of burning it, improvement in biological activities in the soil, growth homogeneity of the crops involved in the cropping system, increasing soil organic matter and its fertility and decreasing soil erosion and soil nutrients washout will be in reach.

## Methods & materials

This managed approach includes permanent abandon of moldboard plow, but implementation of all the summer and fall seedbed preparations only with shallow depth (15-20 Cm) disk harrow practice only to lose soil and incorporation of previous crop residue into the soil. In order to implement the principles of minimum possible soil disturbance, keeping maximum allowable diversified residue partly on the soil surface (15-30%) and mostly (>30%) into the soil and diversify adaptable crop sequences in CA based small scale irrigated lands (less than 5 hectares), we should consider challenges of coordination among all the components of the production system. This system as CA based sequential cropping system technology is in need of integration with furrow irrigated raised bed planting system technology for the economic short crop sequences of two years- three or four crops. The so called system is practically implemented as two double minimum tillage cropping systems each with different summer and winter crop types.

## The objectives for implementing a successful CA based irrigated sequential cropping system

- To provide a proper environment for seeds to germinate and roots to grow. In this regard, in no-till we have challenges of soil compaction, volunteer weed of wheat as previous crop, annual and perennial weed infestation especially from the fourth cropping year, levelled land modification to not-levelled rutted land through the cropping years including different crops of crop sequence (sequential cropping system). A good seedbed is very much important to get the best results as maximum biomass and grain yield which should be concentrated in any production system considering the principles of CA but with location limitations and constraints. This can be achieved by integration of minimum tillage instead of no-till at least in the preliminary years of transition from conventional to no-till until getting the minimum required soil physical, chemical and biological soil characteristics needed for no-till success.
- To kill weeds and disrupt pest lifecycles according to the agricultural laws in Iran the usage of GM crop is forbidden so the dependency to the herbicides would be increasing which will be a challenge in the next years of no-till adoption. In order to solve this very much important problem we are in need of creating a moderate production environment not completely relied on one approach but include much more ones in a coordinated manner. For instance, in Karaj we have introduced an integrated weed control approach containing cultural, mechanical and chemical treatments through integrating double minimum tillage and furrow irrigated raised bed planting system (FIRBPS). In fact, this managed approach is primarily dependent to cultural and mechanical but secondarily to the chemical weed control.
- To incorporate nutrients into the soil one of the main issues reported for continuous no-till farming is stratification of some nutrients like phosphorous which makes many problems for the production environment in the next years on. So, We are in need of introducing solutions like strategic tillage every five years to incorporate nutrients in the soil to get it balanced or implement shallow depth minimum tillage to redistribute the nutrients in the soil profile to let different roots of the crops inside the diversified crop sequence considered for the target area.
- To manage crop residues well adopted with the climatic and seasonal limitations and constraints and in order to have a good crop establishment, the 1st priority would be to move on in the system considering residue management techniques in line with other components.
- To reduce the number of tillage operations in a decreasing scale of dependence based on CA principles through implementation of the continuous rotational cropping systems cycles, we are in need of monitoring the soil in response to what has been done on the soil. In other words, the moderation principle would be a prerequisite to get positive results. This means we should not emphasize on any tillage.
- Economic benefits including 1) lower fuel costs, 2) reduced amount of tillage equipment needed, 3) lower labor requirements, 4) reduced soil loss from water and wind erosion, and 5) conservation of soil moisture.
- I am of the understanding that anaerobic soils (>300 psi) penetrometer measurement) are the ideal environment harboring disease, toxin producing and denitrification related organisms.
- Anaerobic conditions favor fermentation (alcohol, methane, formaldehyde, cyanide, etc.) and sterilization of beneficial soil biology. Anaerobic soils are prone to erosion & drought due to the inability of water to infiltrate into non-existent pore space.
- Porous, high organic matter content, aerobic soils have lower chance of creating disease friendly conditions, have better water & nutrient holding capacity, have better nutrient exchange for optimal food plant health & yield (truly healthy plants aren't susceptible to disease or insect attack), and increased resistance to drought & erosion.
- I agree, the anaerobic and aerobic soil zones should not be mixed together (unless using amendments to modify anaerobic soil zone structure). Tillage, if implemented, should be limited to the aerobic zone. While not a proponent of tillage, there are chemical & biological methods of creating aerobic soil conditions.

## The reasons not to implement no-till system

Farm land small size, no possibility to introduce summer and winter cover crop in dominant double cropping of wheat/maize to have a permanent soil cover, no access to multipurpose seeders to implement seeding the seeds of all the crop types in the target diversified sequential cropping systems in the area, increasing dependency of the system to the herbicides in the format of no-tillage, increasing soil compaction at least in the first years of its implementation, practical challenges of no-tilling in irrigated lands such as irrigation with non-affordable expensive systems which are not acceptable by the small scale farmers and no good land levelling and unsuccessful fall seeding due to the cold and wet soil are currently seen in temperate-cold climate of Karaj.

## The recommended solution

Non-inversion shallow depth tillage with disk for seedbed preparation and seeding with conventional seeders on bed tops with the fixed width of 75 Cm for all the crop types in the sequential cropping system but with the specific seed rate for each crop.

## Results & conclusions

The suggested integrated technology help the soil to be cooler in the Summer and warmer in the Fall to have more established seedlings in shorter time and because of more soil ventilation which should not be less important than soil moisture especially in the Fall. In fact, the shallow soil tillage has many advantages such as less time and energy consumption, dividing soil tillage in two categories of mechanical for the top layer and biological for the bottom layer done by the earthworms. In other words, through incorporation of previous crop residue into the soil we help the earthworms to consume less energy for transferring soil surface residue into the soil hence helping them to have more body mass and energy to better redistribution of organic matter in the bottom soil layer. This can lead to more and better soil aggregates which has a positive effect on its functionality. The long term continuation of this practice would be to upgrade the amount of soil organic matter from about 1 percent to even 4 percent in the shortest time because in order to have a healthy soil with its best functioning we need to have equal amount of moisture and oxygen for the chemical and biological reactions of the soil. This results in some characteristics of homogenous growth, biomass, height, chlorophyll and healthy crop plants alongside the farm.